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(54) Golf ball

(57) A golf ball is provided having a core and a cover wherein the cover comprises a blend of low flexural modulus ionomer resins. Surprisingly, such blends exhibit spin properties, coefficient of restitution, initial velocities and cut and abrasion resistance comparable to or better than golf balls of the prior art. In each case the resins have a flexural modulus of 2000 - 15000 p.s.i. and the cover has a Shore D hardness of 35 - 55.

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GOLF BALL

This invention relates to a golf ball having an improved cover composition which imparts to the ball superior playing properties and superior cut and abrasion resistance.

For many years golf balls of the prior art were provided with covers made of balata or balata blends. Such balata covers were readily adaptable to the molding techniques commonly used in golf ball manufacture. Balata covered balls were also preferred by relatively skilled players because the relative softness of the cover material allowed the player to apply a spin to the ball to control the ball in flight and on the green. Such balata covered balls were disadvantageous, however, in that they had low tear resistance and were easily cut in play. Balata covered balls therefore had a relatively short life span.

To overcome these deficiencies, golf ball covers have been manufactured of a family of ionomers sold by E.I. duPont de Nemours & Company under the trademark SURLYN. These ionomers are described in U.S. Patent No. 3,264,272, issued August 2, 1966 to Rees, assigned to duPont and entitled "Ionic Hydrocarbon Polymers," the disclosure of which is incorporated herein by reference.

Golf balls having covers of various ionomers and ionomer blends have been disclosed in the prior art:

U.S. Patent No. 3,454,280, issued July 8, 1969 to Harrison, discloses golf balls having covers comprising a copolymer of ethylene and an unsaturated monocarboxylic acid, where the copolymer may be a terpolymer of ethylene, an unsaturated monocarboxylic acid, and a metal salt of an

unsaturated monocarboxylic acid. The golf balls have improved cutting resistance relative to balata covered balls.

U.S. Patent No. 3,819,768, issued June 25, 1974 to Molitor, discloses golf balls having covers comprising mixtures of sodium and zinc salts of ionic copolymers of olefins and unsaturated monocarboxylic acids.

U.S. Patent No. 4,323,247, issued April 6, 1982 to Keches, discloses golf balls having covers composed of at least three ionomeric resins wherein one of the resins is a copolymer of ethylene and a sodium salt of methacrylic acid and the other two are copolymers of ethylene and a zinc salt of methacrylic acid, each of the three ionomeric resins having specifically defined amounts of free acid and metal ion.

U.S. Patent No. 4,337,947, issued July 6, 1982 to Saito et al., discloses a golf ball having a cover comprising an ionomer which is a copolymer of an olefin and a salt of an unsaturated carboxylic acid, and a polyester elastomer.

U.S. Patent No. 4,884,814, issued December 5, 1989 to Sullivan, discloses a golf ball having a cover comprising a blend of a hard ionomer resin and a soft ionomer resin.

U.S. Patent No. 4,911,451, issued March 27, 1990 to Sullivan et al., discloses a golf ball having a cover comprising blends of zinc or sodium neutralized ethylene-acrylic acid copolymers.

The golf balls of the prior art as disclosed in the aforementioned U.S. patents have varying properties with regard to playability, cut resistance, coefficient of restitution, and initial velocity.

It is an object of the invention to provide a golf ball having an improved cover composition which imparts the playability characteristics desired by the skilled player, while at the same time providing excellent cut resistance,

abrasion resistance, coefficient of restitution, and initial velocity.

In accordance with the invention, a novel golf ball is provided having a unique cover composition which imparts improved properties to the golf ball. Applicant has discovered that, unexpectedly, golf ball covers can be made of blends of only low modulus ionomeric resins, which blends have hardness values comparable to those of Balata covers while exhibiting cut resistance and playing life comparable to prior art golf balls having covers of blends having higher hardness values and including higher modulus ionomeric resins.

Each of the low modulus ionomeric resins used in the improved cover of the inventive golf balls has a flexural modulus value of about 2000 psi to about 15,000 psi. The covers of golf balls of the instant invention have a Shore D hardness value in the range of about 35 to about 55. This compares favorably with Balata covers, which typically have a Shore D hardness of about 43. It has been found that golf balls made in accordance with the instant invention have excellent playability characteristics, coefficients of restitution, and initial velocity values.

Golf balls made in accordance with the instant invention comprise a core and a cover, wherein the cover is made of an improved composition comprising two or more ionomer resins having relatively low flexural modulus values and excluding ionomer resins having relatively high flexural modulus values. The resins of the cover composition are selected and combined in pre-determined proportions such that the Shore D value of the cover composition is in the range of about 35-55.

For purposes of this patent specification, a low modulus resin is one which has a flexural modulus value of about 2,000-15,000 psi when measured in accordance with ASTM method D-790. Thus, the low modulus resins used in the golf balls of the instant invention are distinguished from the high modulus resins used in prior art golf balls and which generally have flexural modulus values in the range of about 30,000-55,000 psi. Similarly, a low modulus resin will typically have a Shore D hardness value in the range of about 20-55 when measured in accordance with ASTM method D-2240. These low modulus resins are distinguished from high modulus resins used in prior art golf balls which have Shore D hardness values of about 60 and above.

Among the low modulus ionomer resins that may be used in the golf ball of the instant invention are some of the low modulus resins sold by the E.I. duPont de Nemours & Co. under the trademark Surlyn. Such low modulus ionomer resins may be a sodium or zinc salt of a terpolymer of an olefin having from 2 to 8 carbon atoms, an unsaturated monocarboxylic acid having from 3 to 8 carbon atoms and an unsaturated monomer of the acrylate ester class having from 2 to 22 carbon atoms. Typically, the olefin may be ethylene, the unsaturated monocarboxylic acid may be methacrylic acid, and the unsaturated monomer of the acrylate ester class may be iso-butyl acrylate or n-butyl acrylate. Exemplary of such resins are those disclosed in U.S. Patent No. 4,690,981, issued September 1, 1987 to Statz, the disclosure of which is incorporated herein by reference in its entirety.

Examples of low modulus ionomer resins suitable for use in the inventive golf balls with improved covers include the following:

Surlyn AD-8265	:	73% ethylene 17% n-butyl acrylate 10% methacrylic acid (sodium salt)
Surlyn AD-8269	:	68% ethylene 23% n-butyl acrylate 9% methacrylic acid (sodium salt)
Surlyn 9020	:	80% ethylene 10% iso-butyl acrylate 10% methacrylic acid (zinc salt)

These resins have the following properties:

	Flexural Modulus (psi)	Shore D Hardness
Surlyn AD-8265	7,100	39
Surlyn AD-8269	2,800	25
Suryln 9020	14,000	55

In accordance with the invention, low modulus ionomer resins such as those identified above can be selected and blended in pre-determined proportions to produce golf ball cover compositions having the desired flexural modulus and Shore D hardness values.

It has been found that, unexpectedly, such golf balls exhibit excellent coefficient of restitution (COR) values. COR is an indication of the distance a golf ball will travel when struck by a golf club. COR is determined by propelling a finished golf ball against a hard surface, and measuring both the initial and the rebound velocity. The COR is the ratio of the rebound velocity over the intial velocity. The inventive golf balls also exhibit excellent initial velocity when struck with a golf club moving at 90 m.p.h. at the point of impact.

Examples of golf balls having covers made of blends of low modulus ionomer resins in accordance with the instant invention are set forth in Table I below. As also shown in Table I, these golf balls have excellent coefficient of restitution and initial velocity values, which those skilled in the art will recognize as comparable to those of other competitive golf balls.

TABLE I

BLENDS		MEAN SHORE D HARDNESS(a)	MEAN FLEXURAL MODULUS(a)	COEFFICIENT OF RESTITUTION(b)	INITIAL VELOCITY, 90 MPH CLUB HEAD SPEED(b)
Example 1					
Component	Parts by Weight				
SURLYN 9020	80	49	11,760 psi	0.638	215.7 ft/sec.
SURLYN AD-8269	20				
TITANIUM DIOXIDE	1.0				
ULTRAMARINE BLUE	0.01				
Example 2					
SURLYN 9020	60	47	10,810 psi	0.633	214.8 ft/sec.
SURLYN AD-8265	30				
SURLYN AD-8269	10				
TITANIUM DIOXIDE	1.0				
ULTRAMARINE BLUE	0.01				
Example 3					
SURLYN 9020	50	47	10,550 psi	0.635	215.1 ft/sec.
SURLYN AD-8265	50				
TITANIUM DIOXIDE	1.0				
ULTRAMARINE BLUE	0.01				
Example 4					
SURLYN 9020	33	35	6,496 psi	0.619	210.5 ft/sec.
SURLYN AD-8269	67				
TITANIUM DIOXIDE	1.0				
ULTRAMARINE BLUE	0.01				
Example 5					
SURLYN 9020	60	43	9,520 psi	0.628	213.0 ft/sec.
SURLYN AD-8269	40				
TITANIUM DIOXIDE	1.0				
ULTRAMARINE BLUE	0.01				

(a) Calculated as the arithmetic mean based on the proportions of each Surlyn resin and neglecting the effects of titanium dioxide and ultramarine blue.

(b) Average of test measurements made on 12 balls for each example blend.

In addition to the foregoing properties, tests were conducted wherein golf balls of the instant invention and of the prior art were subjected to repeated impacts using a square groove pitching wedge golf club. In these tests, three blends were prepared as follows:

Blend A:	Surlyn 8940	55 parts
	Surlyn 8269	45 parts
	Titanium Dioxide	1 part
	Ultramarine Blue	0.01 part
	Mean Shore D hardness	47
	Mean flexural modulus	29,310 psi
Blend B:	Surlyn 9910	50 parts
	Surlyn 8940	50 parts
	Titanium Dioxide	1 part
	Ultramarine Blue	0.01 part
	Mean Shore D hardness	65.5
	Mean flexural modulus	49,500 psi
Blend C:	Surlyn 9020	70 parts
	Surlyn 8269	30 parts
	Titanium Dioxide	1 part
	Ultramarine Blue	0.01 part
	Mean Shore D hardness	46
	Mean flexural modulus	10,640 psi

For each of these blends, the Shore D hardness value and the flexural modulus values were calculated in the same manner as was used for Examples 1-5 in Table 1 above. Blend A is a typical blend of a high modulus resin and a low modulus resin such as those blends disclosed in prior art patent U.S. 4,884,814; Blend B is a typical prior art blend of only high modulus resins; and Blend C is a blend of only low modulus resins in accordance with the instant invention. It may be seen that Blend C of the instant invention has a Shore D hardness value very similar to prior art Blend A, but a much lower flexural modulus value.

The blends were tested by preparing three sets of six golf balls per set, each set of golf balls having covers prepared of one of the three blends, for a total of 18 balls. Each golf ball was struck six times in the exact same spot at

about 20 second intervals using a 50° loft, investment cast, square groove pitching wedge. A square groove wedge was selected for this test because the sharp edges of the square grooves are known to severely scrape and lacerate the surface of the golf ball, such that serious damage would be expected.

The abrasion and cut resistance of the cover compositions were evaluated on a scale of 1-3, where 1 represents noticeable shredding of the cover and severe surface roughness due to abrasion; 2 represents small pieces cut from the ball, particularly at the edges of the dimples, plus noticeable abrasion; and 3 represents no shredding and only minor abrasion. The results within each set showed great consistency, and are set forth in Table II below.

TABLE II

Blend	Abrasion and Cut Resistance
A	2
B	1
C	3

From these results, it may be seen that the balls of the instant invention having covers made of low modulus, lower hardness Blend C show significantly greater resistance to cutting and abrasion under severe test conditions than either of the higher modulus Blends A or B.

Another property of golf balls which is highly valued by skilled players is a high spin rate, which allows the skilled player to better control the placement of the ball on the green. To evaluate the spin rate of golf balls of the instant invention, three sets of golf balls of 24 balls per set were prepared, each set of balls having covers of Blends A, B, and C as described above, respectively, for a total of 72 balls. Each ball was struck with a 50° pitching wedge swung at 75 m.p.h. and the spin rate was measured by standard

techniques. The average spin rates for the balls of each of the three blends are as follows:

TABLE III

Blend	Average Spin Rate (r.p.m.)
A	9320
B	8520
C	9515

Thus, it may be seen that the low modulus cover composition of Blend C advantageously gives the golf balls of the instant invention a spin rate significantly higher than either of the prior art golf balls having higher modulus covers.

Balls having covers of Blends A, B, and C were also tested for their initial velocity, carry distance (the distance the ball travels between the tee and the place at which it first lands on the ground), and the carry and run distance (the carry distance plus the further distance the ball bounces or rolls before coming to a stop). To evaluate these properties for golf balls of the instant invention, three sets of 24 balls each having covers of Blends A, B, and C, respectively, were prepared, for a total of 72 balls, as described above for the spin rate tests. Each ball was struck with a 11° driver swung at 95 m.p.h. The results are set forth in Table IV below.

TABLE IV

Blend	Average Initial Velocity (ft./sec.)	Average Carry Distance (ft.)	Average Carry and Run Distance (ft.)
A	215.5	229	247
B	217.7	232	251
C	215.8	231	248

This data indicates that golf balls of the instant invention having cover compositions of low modulus Blend C have performance values comparable to those of prior art golf balls having cover compositions of high modulus Blends A and B.

Those skilled in the art will recognize that certain compatible materials can be added to the cover compositions of the golf balls of the instant invention without adversely affecting the improved properties of those compositions. The compatible materials may include coloring agents, such as dyes and pigments, fillers, antioxidants, antistatic agents, and stabilizers. These additives generally comprise no more than about 5% by weight of the cover composition, and typically are on the order of about 1-2% or less by weight of the cover composition.

The golf balls of the instant invention are preferably made by injection molding the cover composition about golf ball cores. The golf ball cores may be of either the solid type or the wound type, as is known in the art. Techniques for injection molding resin cover compositions about golf ball cores are also well known to those skilled in the art of golf ball manufacture.

The foregoing detailed description of the invention is not intended to limit the scope of the invention. Other embodiments and modifications, which do not consititute departures from the spirit of the invention, will be readily appreciated by those skilled in the art from the foregoing specification.

CLAIMS:

1. A golf ball having a core and a cover, said cover comprising a blend of two or more ionomer resins, wherein each ionomer resin present in said blend has a flexural modulus value of about 2000 psi to about 15,000 psi, said cover having a Shore D hardness value in the range of about 35 to about 55.

2. The golf ball of claim 1 wherein each said ionomer resin is a metal salt of a terpolymer of an olefin having from 2 to 8 carbon atoms, an unsaturated monocarboxylic acid having from 3 to 8 carbon atoms, and an unsaturated monomer of the acrylate ester class having from 2 to 22 carbon atoms.

3. The golf ball of claim 2 wherein said olefin is ethylene.

4. The golf ball of claim 2 wherein said unsaturated monocarboxylic acid is methacrylic acid.

5. The golf ball of claim 2 wherein said unsaturated monomer of the acrylate ester class is selected from the group consisting of n-butyl acrylate and iso-butyl acrylate.

6. The golf ball of claim 2 wherein said metal is selected from the group consisting of sodium and zinc.

7. The golf ball of claim 1 wherein said cover comprises (a) a zinc salt of a terpolymer of ethylene, methacrylic acid, and iso-butyl acrylate, and (b) a sodium salt of a terpolymer of ethylene, methacrylic acid, and n-butyl acrylate.

8. The golf ball of claim 7 wherein said cover further comprises (c) a second sodium salt of a terpolymer of ethylene, methacrylic acid, and n-butyl acrylate.

9. A golf ball as claimed in claim 1 substantially as hereinbefore described.